



Potentially Useful Analytic Information from Biomass R&D Activities

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(EERE)**

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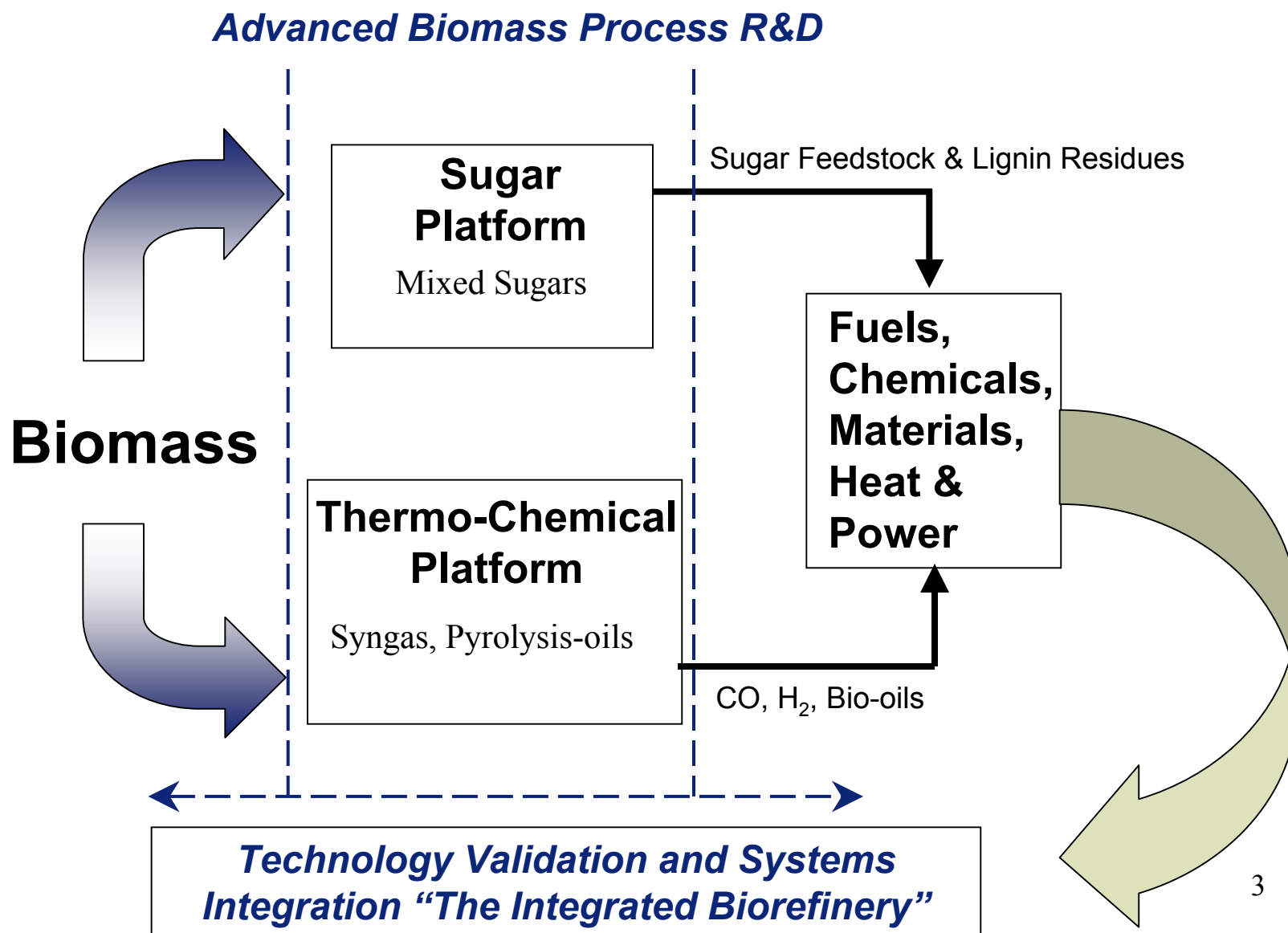


About EERE's OPBA

- Office of Planning, Budget and Analysis; Deputy Assistant Secretary for Business Administration
- Supports each of the 11 technology program offices
- Budget requests assistance and coordination; policy and market analysis; benefits analysis; planning integration; EERE data books and data systems; program evaluation guidance; cross-cutting activities; interface with CFO, NAS, National Assoc. of Public Administrators, etc.



Biomass Technology Platforms





Biorefineries Already Exist

Multiple Products from Biomass

- Corn wet mills (Sugar-Based)
 - Ethanol
 - Sweeteners
 - Corn oil
 - Corn starch
 - Etc.
 - Traditional feedstock is corn kernels
- Corn dry mills (Sugar-Based)
 - Ethanol
 - Animal feed (DDGS)
 - Traditional feedstock is corn kernels
- Pulp & paper mills



Emerging Biorefineries

- R&D for dry mills (sugar-based): enzymatic hydrolysis of cellulose from fiber in the corn kernel and cellulose in the stover (residues)
- In a few years – dry mills' production of additional ethanol and co-products using corn fiber, followed by the use of corn stover



Future Biorefineries

- Concepts beyond emerging biorefineries
 - Advanced sugar-based products?
 - Syngas-based concepts?
 - Combination of sugar-based and syngas-based production of fuels and chemicals?

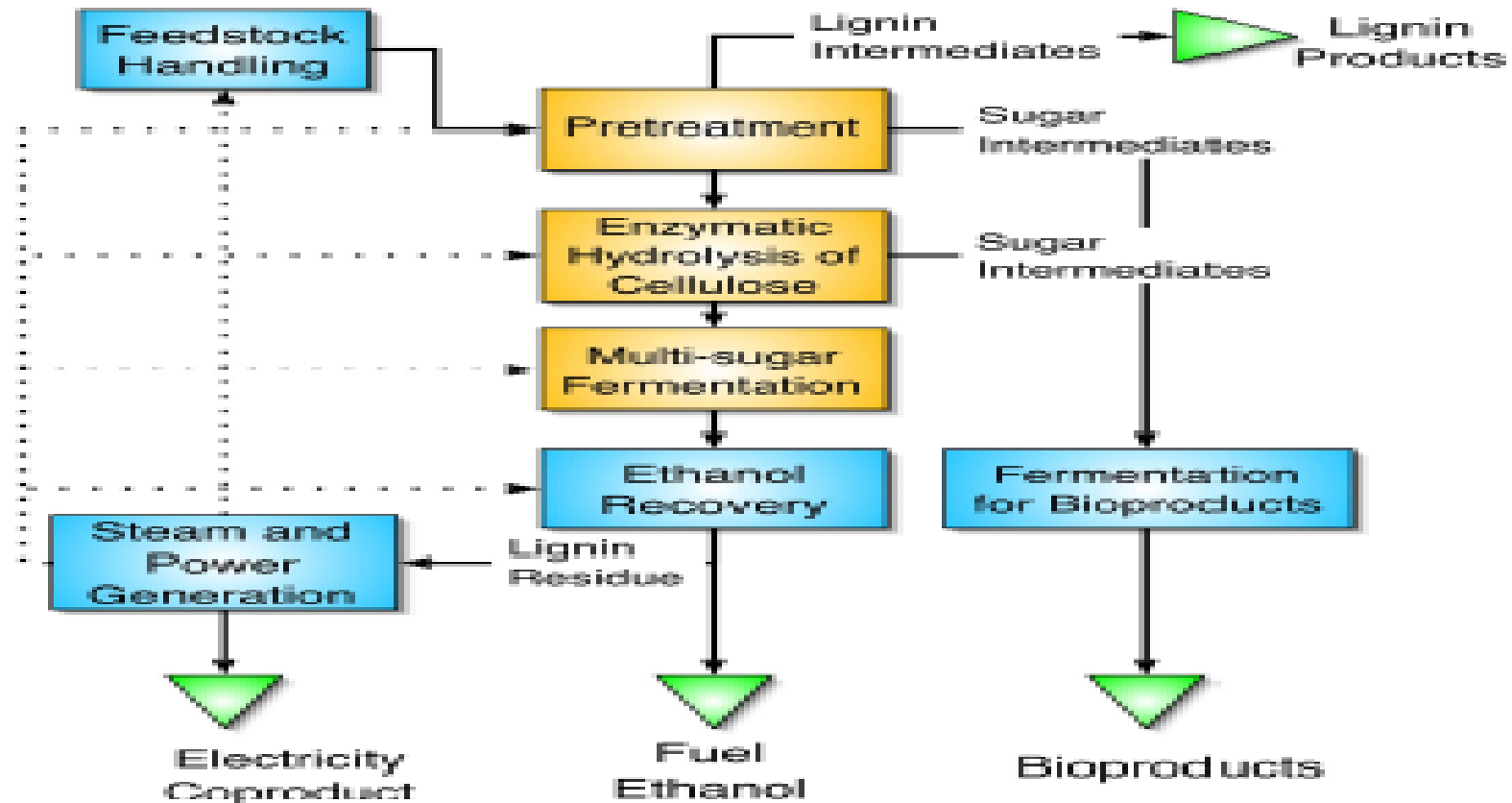


“Specialty” Biorefineries

- Biorefineries producing bio-based products, not fuels, are also possible in the near term and mid term
- Example – Cargill Dow’s “Natureworks”
 - Biodegradable Polylactic Acid (PLA) made from corn sugar
 - Fibers, food containers, and other products
 - Competes with petroleum-based polystyrene, polyethylene, etc.



Sugar-Based Example



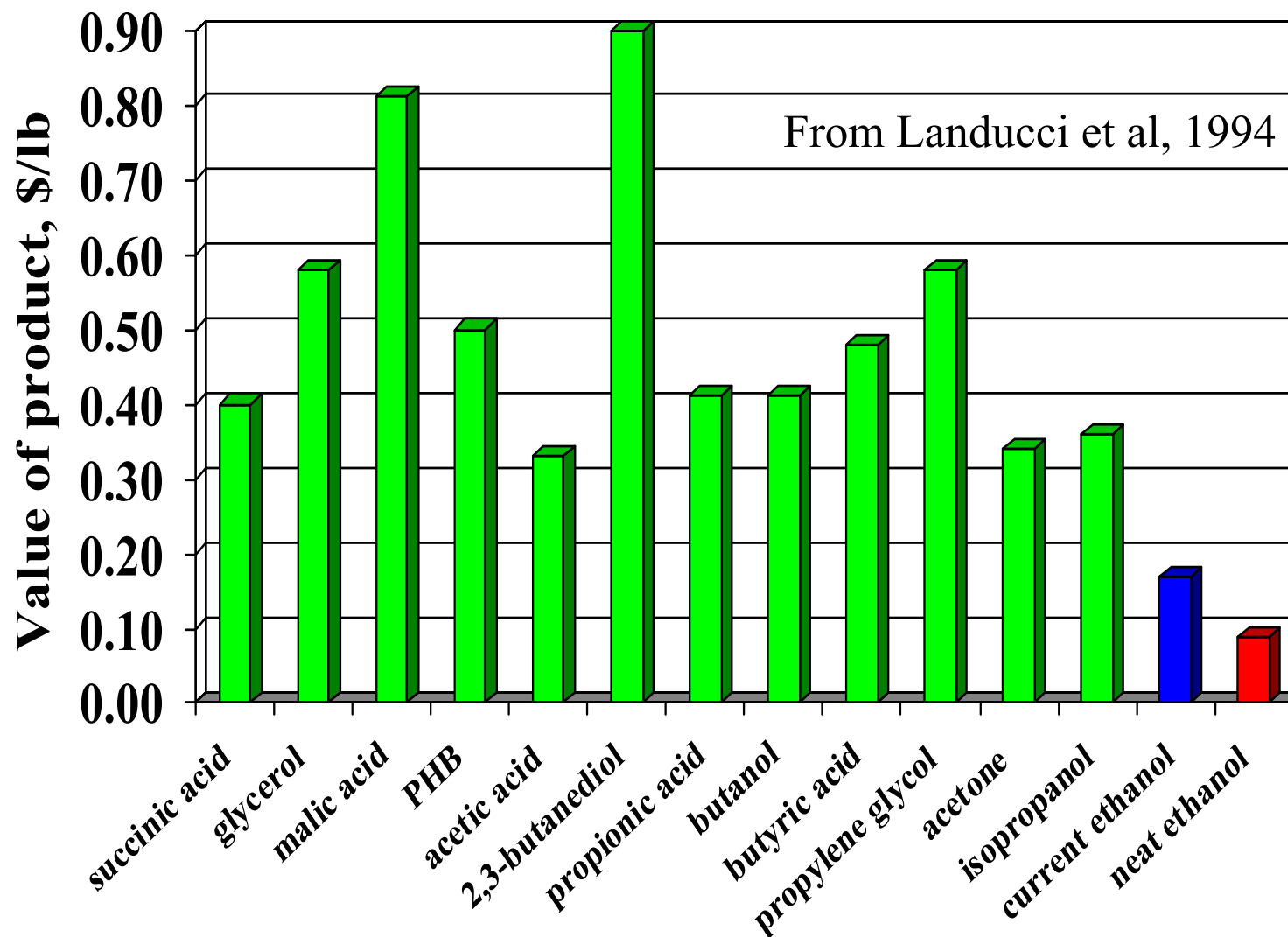
NREL's illustrative sugar-based biorefinery



- Biorefineries produce chemicals and materials (bio-based products) in addition to fuels, heat and power
- 2004 PNNL/NREL draft report on 12 promising bio-based chemical intermediates – EERE is obtaining industry's feedback
- Through 2010: technology development for 3 new bio-based chemicals by DOE in partnership with industry



Chemicals vs. Ethanol Values





Energy Crop Potential

Relying on USDA Agricultural Research Service's
R&D on switchgrass

Relying on Forest Service (USDA FS)'s
R&D on promising tree species



Potential Beyond Starch Feedstock

- Near to mid term: future ethanol from corn fiber will be 10% of current ethanol from starch in corn kernels
- Mid to long term: stover and other agri-residues, some forest residues and other wastes, some energy crops (100% ethanol increase over corn kernels base)
- Long term: additional forest residues and other wastes, and additional energy crops (additional 100% ethanol increase over corn kernels base)
- U.S. agriculture can support a corn kernels base of 8-9 billion gallons per year (informal consensus)



Remaining Slides

- Insights from past analysis
- An analyst's wish list



GHG and Land Use Changes

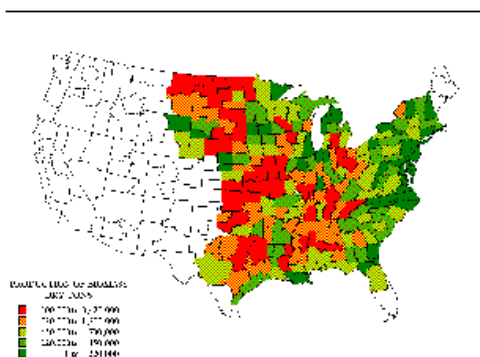
- Land use changes have a significant impact on greenhouse gases results
- A better understanding of the following is needed:
 - Economic alternatives and baseline land use
 - Soil carbon changes
 - Biomass harvest yields and improvement over time
 - Nitrogen releases and changes associated with alternative land uses



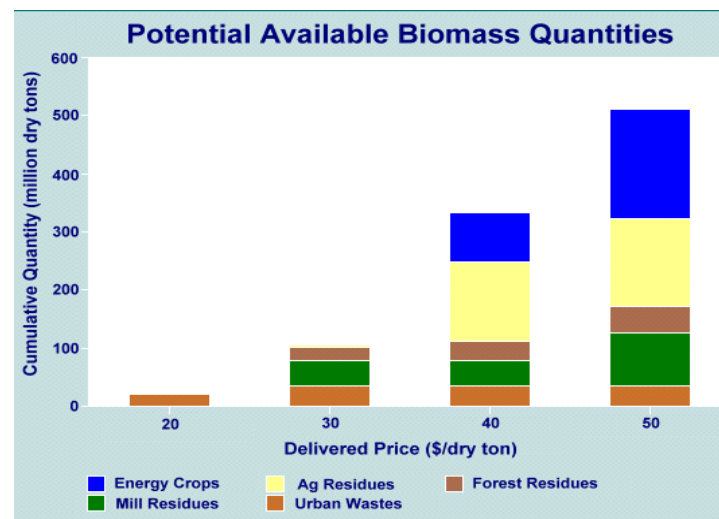
Feedstock Analysis

- Detailed Analysis for Energy Crops in 2008 using POLYSYS Model
- Potential Availability on Biomass Feedstocks

Bioenergy Crop Production-- Production Scenario; \$40/dt



OAK RIDGE NATIONAL LABORATORY
U.S. DEPARTMENT OF ENERGY
March 2000



Source: Biomass Feedstock Availability in the United States: 1999 State Level Analysis, Oak Ridge National Laboratory

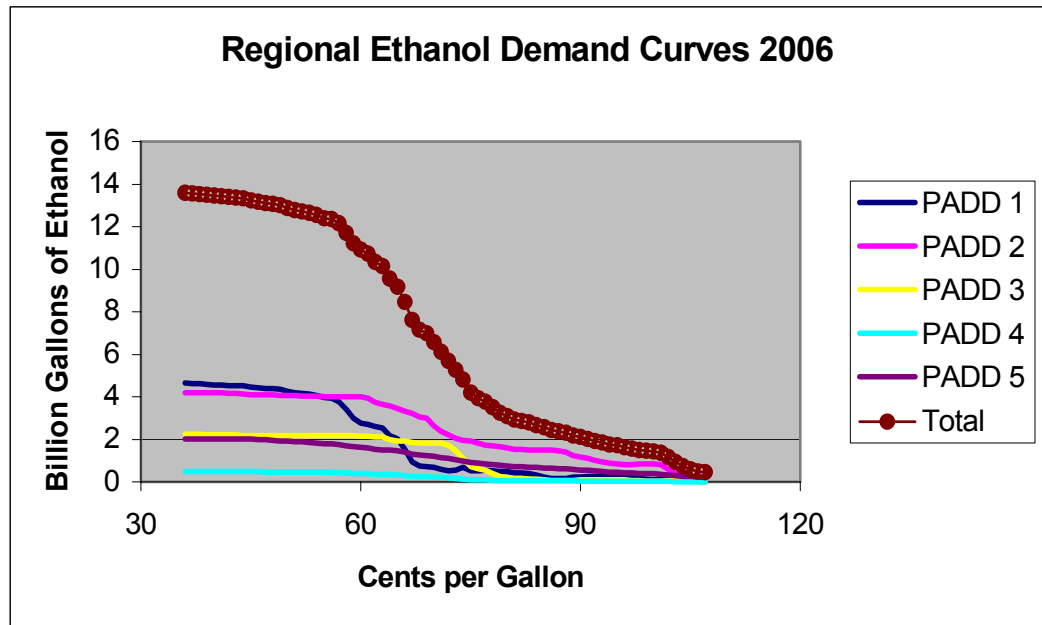


Ethanol Demand Analysis

- ORNL/RYM used to develop ethanol demand curve
- Detailed regional and seasonal analyses

Analyzed many scenarios:

- With and without MTBE restrictions
- With and without RFG oxygen requirements
- Low sulfur gasoline standards
- Stricter emissions standards
- With and without RVP waivers for conventional
- Various AEO projections of oil prices and gasoline demand



- RFG Oxygen requirement removed.
- No MTBE in PADD 2 and California, MTBE limited to 3 % in PADDs 1 and 3
- Ethanol price is price to refiners, i.e., net of tax incentives..
- 1997 dollars.



Ethanol Logistics Analysis

- Transportation and infrastructure for Renewable Fuels Standard (5 vs. 10 billion gallons) by Downstream Alternatives, Inc.
- Most of infrastructure costs are incurred at terminals
- Retail station costs for E10 are 0.01cent per gallon of ethanol versus 5.7 cents for E85 due to lower throughput of E85

Costs in cents per gallon of ethanol			
	<u>Amortized</u>		
	<u>Investment</u>	<u>Freight</u>	<u>Total</u>
5 billion gallons	0.66	10.5	11.1
10 billion gallons	0.60	5.8	6.4
Difference	0.06	4.7	4.8



Potential Constraints

- Blending limitations: 10% ethanol by volume maximum (5.7% in California)
- Ethanol incentive favors E10, not E85
- Infrastructure costs and barriers
 - Fueling stations for 85% ethanol by volume (E85)
 - Pipelines – lower distribution costs, but when will volume justify introduction?
- Multiple bio-based products and market characteristics
- Electricity sales to potential customers near biorefineries



- A few “reference” biorefinery concepts and costs
- Costs and market information for new fuels and bio-based products from future “reference” biorefinery concepts
- Program funding (congressionally directed projects) affect R&D resources and consequently, data generation schedule